

New records of Actinopterygian fishes from the Canary Islands: tropicalization as the most important driving force increasing fish diversity

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ABSTRACT

The presence of several actinopterygians species are reported based mainly on photographic documents taken in various islands. Three tropical origin species are recorded for the first time from the Canary Islands: *Uraspis secunda*, *Cubiceps capensis* and *Cantherines macrocerus*. Also, the thermophilic *Psettodes* cf. *bennettii* and the Macaronesian anguilliform, *Paraconger* cf. *macrops* are tentatively recorded for the first time. In addition, the distribution range into the Canary archipelago of two previously established non-native tropical species, *Hippocampus algiricus* and *Microlipophrys velifer*, is extended. The cases of thermophilic species seem to respond to natural range spreading processes, probably related to the sea water warming in the Atlantic, while *P. macrops* has probably passed unnoticed until now. Biogeographic data are also included.

Key words: actinopterygians, new records, *Uraspis secunda*, *Psettodes* cf. *bennettii*, *Cubiceps capensis*, *Paraconger* cf. *macrops*, *Microlipophrys velifer*, *Hippocampus algiricus* and *Cantherines macrocerus*.

RESUMEN

Se estudia la presencia en Canarias de varias especies de peces actinopterigios en base, fundamentalmente, a fotografías realizadas en diferentes islas. Se registra por primera vez la presencia de tres especies de origen tropical: *Uraspis secunda*, *Cubiceps capensis* y *Cantherines macrocerus*. También se registran tentativamente por primera vez el pleuronectiforme termófilo *Psettodes* cf. *bennettii* y el anguiliforme de distribución maca-

ronésica *Paraconger* cf. *macrops*. Además, se amplía el rango de distribución insular e interinsular de otras dos especies tropicales establecidas en una de las islas desde hace años: *Hippocampus algiricus* y *Microlipophrys velifer*. En el caso de las especies termófilas parece tratarse de procesos de expansión natural de las áreas de distribución, mientras que la especie macaronésica puede haber pasado desapercibida en estudios anteriores. Se aportan también datos biogeográficos.

Palabras clave: actinoptеригios, nuevas citas, *Uraspis secunda*, *Psettodes* cf. *bennettii*, *Cubiceps capensis*, *Paraconger* cf. *macrops*, *Microlipophrys velifer*, *Hippocampus algiricus* y *Cantherines macrocerus*.

1. INTRODUCTION

The littoral ichthyofauna from the Canary Islands has experienced an obvious tropicalization process since the late 80s, but particularly since the 90s, resulting in the occurrence of a great number of termophilic species of tropical origin (BRITO *et al.*, 2002, 2005, 2007, 2011; BRITO & FALCÓN, 2007; MARSHALL *et al.*, 2009; WIENERROITHER *et al.*, 2009; ESCÁNEZ & BRITO, 2011; ESPINO *et al.*, 2014; GARCÍA-MEDEROS & TUSET, 2014; ALMÓN *et al.*, 2014; TRIAY-PORTELLA *et al.*, 2015; FALCÓN, 2015; FALCÓN *et al.*, 2015; ESPINO *et al.*, 2015 a; OTERO-FERRER *et al.*, 2015; PAJUELO *et al.*, 2016). Most of the fishes recorded are benthic or benthopelagic species, and some of them have been successfully settled in the area (BRITO *et al.*, 2005; FALCÓN *et al.*, 2015; ESPINO *et al.*, 2015 b; FALCÓN, 2015). The same process have been observed in the north-eastern Atlantic and the Mediterranean (e.g. PERRY *et al.*, 2005; OCCHIPINTI-AMBROGI, 2007; WIRTZ *et al.*, 2008; BAÑÓN *et al.*, 2010; ZENETOS *et al.*, 2012; AFONSO *et al.*, 2013; HORTA-COSTA *et al.*, 2014), which has led to the occurrence of species that are well established in the Canaries in some cases. This process is closely linked to the increasingly warm sea water temperatures registered in these areas as a result of climate change, although introductions owing to anthropogenic activities have also been significant. In the Canary Islands, the occurrence of certain thermophilic species close to or in the surroundings of main harbours has been attributed to maritime traffic as introduction vector (ballast water transport and associated fish to oil platforms) (BRITO & FALCÓN, 1996; BRITO *et al.*, 2005; BRITO *et al.*, 2011; ESPINO *et al.*, 2015 a; FALCÓN *et al.*, 2015; FALCÓN, 2015; TRIAY-PORTELLA *et al.*, 2015; PAJUELO *et al.*, 2016).

Tropicalization represents both the arrival of species of southern distribution (tropicalization in the strict sense) and the geographic and population expansion of native thermophilic species (meridionalization). In the case of the Canaries, meridionalization process also involves a longitudinal advance of certain species eastwards following the environmental gradient of the archipelago (BRITO *et al.*, 2005; ESPINO *et al.*, 2014; FALCÓN, 2015).

The present paper records the presence of several species based mainly on photographs and some visual examination of the specimens as well. The photo-identification is a good method to identify most of the littoral fishes species, except for some small ones as gobies and cleanfishes, when the images allow to see the differential details to identify at the species or genus level with absolute certainty, as in this case. We report the presence

of four tropical species for the first time in the Canaries, and recorded the expansion into the archipelago of two non-native species previously established years ago. In addition, the presence of a Macaronesian fish species has been detected, until now unreported from the Canary Islands. Furthermore, characteristics for the identification of these species and biogeographic data are provided.

2. MATERIAL AND METHODS

Some images and data examined were provided by the RedPromar network belonging to the Regional Government of the Canary Islands (<http://www.redpromar.com/>) - a tool comprised by observers using the 'citizen science' concept to monitor the marine biodiversity -, as well as directly from their authors. Data and photos on three species come from surveys by the authors in the natural environment or in fish markets. For some of the latter specimens, to be indicated, it was possible to examine morphological details, although they were not available for morphometric analysis.

3. RESULTS

Family Carangidae

Uraspis secunda (Poey, 1860) (Figure 1 A)

One individual caught with hand line at El Bajón de La Restinga (27° 38.05'N 17° 59.31'W; El Hierro) on 23 May 2017. The fish was caught during the day with hand line by a fishermen belonging to the artisanal fleet of the island.

This specimen was examined in detail and it presented the same characters attributed to the genus and species by SMITH-VANIZ (2016). Anyway, according to this author, adults of *U. secunda* and *U. helvola* (Forster, 1801) are virtually impossible to distinguish although juvenile characters involving allometric growth patterns suggest that they may be distinct species. If subsequent studies indicate that these two nominal species are conspecific, the oldest available name is *Uraspis helvola*. *U. secunda* is mainly a pelagic oceanic species with pantropical distribution; in the eastern Atlantic it has been recorded from the Cape Verde Islands and outer parts of continental shelf and slope from Mauritania to Angola (SMITH-VANIZ, 2016).

Family Psettodidae

Psettodes cf. *bennettii* Steindachner, 1870 (Figure 1 B)

One specimen caught during a night angling from the shore on 18 April 2017, in Mesa del Mar (28° 30.27'N 16° 25.47'W, Tacoronte, Tenerife). The fisherman returned it to the sea thinking it was an anomalous fish due to the position of its eyes.

The study of one single image available confirmed that the individual belongs to the genus *Psettodes*, but it was not allow us to distinguish the species. The genus *Psettodes* includes three species, two of them, *P. bennettii* and *P. belcheri* Bennett, 1831 are only known from the eastern Atlantic and one, *P. erumei* (Bloch & Schneider, 1801), from the Indo-Pa-

cific. Both Atlantic species are taxonomic closely related bottom-living fishes occurring in coastal waters and on the continental shelf, and have basic tropical distributions (MUNROE, 2016). The tentative classification as *P. bennettii* is due to its northern distribution from Western Sahara (about 25°N) to Guinea (about 10°N), while *P. belcheri* is distributed from Western Sahara (24° N) and Mauritania, but more commonly from Guinea (about 10°N), to Angola (about 17°S) (MUNROE, 2016). However, according to CAMARA *et al.* (2015), more research is needed to determine if *P. bennettii* and *P. belcheri* are separate species.

Family Nomeidae

Cubiceps capensis (Smith, 1845) (Figure 1 C-D)

Two specimens; one collected by hand at night on very shallow waters of Playa de La Restinga (27° 38.44'N 17° 58.81'W, Puerto de la Restinga, El Hierro), and which was preserved in the fish market; the second one was trapped in the filter grid of the Granadilla electric power station (28° 5.13'N 16° 29.46'W, Tenerife) on 21 May 2017, and was released to the sea after being photographed.

The specimen caught from La Restinga was examined, and showed the characteristics that identify the species, such as scales on top of head extend forward of eyes and teeth on tongue and on roof of mouth pointed, in a single median row (HAEDRICH, 2016). This specimen is currently part of a detailed comparative study on the species and genus in the eastern Atlantic (J. Gustavo-González-Lorenzo, pers. com.). According to HAEDRICH (2016), this species is rarely seen and occurs in subtropical waters of all oceans.

Family Congridae

Paraconger cf. macrops (Günther, 1870) (Figure 1 E)

One individual sighted and photographed during a diurnal diving at El Desierto (27° 40.74'N 18° 01.92'W, La Restinga-Mar de las Calmas Marine Reserve, El Hierro) on 27 May 2017, at 15-17 m of depth. The specimen was observed buried into the sediment, with only the head exposed.

There are two species occurring in the eastern Atlantic, *P. macrops*, previously only known from Azores and Madeira, and *P. notialis* Kanazawa, 1961, which is found from Cape Verde Islands and Senegal southwards to Angola (BLACHE & BAUCHOT, 1976; SALDANHA, 1981; BRITO *et al.*, 1999; SMITH, 2016). They are mainly differentiated by the number of vertebrae and lateral line pores before anus (BLACHE & BAUCHOT, 1976; SMITH, 2016), details which cannot be observed in the images examined. The tentative specific assignation to *P. macrops* is based on the shape of the upper labial flange and the eyes, comparing with the illustrations from the bibliography (BLACHE & BAUCHOT, 1976; SMITH, 2016) and the images of individuals photographed in the Azores obtained from Internet. Anyways, confirmation is needed when at least one specimen can be examined in detail. According to BAUCHOT & SALDANHA (1986), *P. macrops* occurs on the shelf on sandy areas of rocky sublittoral zone between 30 and 100 m of depth, burrows in the sediment during the day and swims actively at night in search of prey.



Figure 1.- A: *Uraspis secunda*; B: *Psettodes cf. bennettii*; C: *Cubiceps capensis* (El Hierro); D: *Cubiceps capensis* (Tenerife); E: *Paraconger cf. macrops*.

Family Monacanthidae

Cantherhines macrocerus (Hollard, 1853) (Figure 2 A)

Two adult males have occurred recently in the Canary waters. The first one was photographed on a rocky bottom off La Palma (coordinates unknown), on July 2016, while the other one was caught in Punta del Hidalgo (28° 34.69'N 16° 20.14'W, Tenerife), using a fish trap, at 40 m of depth.

The photos examined allowed us to identify the species by its characteristic colour pattern: brown or irregular mixtures of brown and orange; often pale spots over much of body and head, and a pair at the top and bottom of the end of the tail base; spines on tail base yellow (ROBERTSON & VAN TASSELL, 2015), having orange colour of patch of setae anterior to the peduncular spines on males (FROESE & PAULY, 2017).

This species is distributed in the western Atlantic from Bermuda, the Bahamas southwards to Brazil, including Trinidad Island; records from North Carolina seem to be vagrants (CARPENTER *et al.*, 2015). In the eastern Atlantic it is known from the Cape Verde Islands (WIRTZ *et al.* 2013; REINER & MARTINS, 1995) and Ascension Island (WIRTZ *et al.*, 2014). It inhabits coastal coral reefs or rocky bottoms between 2 and 40 m of depth (FROESE & PAULY, 2017). Its ability to travel long distances under drifting floating objects is known (LUIS *et al.*, 2015).

Family Syngnathidae

Hippocampus algiricus Kaup, 1856 (Figure 2 B)

One individual sighted close to the hot water outlet of Las Caletillas electric power station (28° 22.90'N 16° 21.355'W, Tenerife), on 2 October 2016, and another one photographed on rocky bottom at 12 m of depth close to La Restinga (27° 38.40'N 17° 58.55'W, El Hierro) on 5 November 2016. In 2015 and 2016 several specimens were also recorded from Sardina del Norte (28° 09.18'N 15° 41.95'W Gran Canaria), although these showed hybridization with *H. Hippocampus* (OTERO-FERRER *et al.*, 2015).

H. algiricus was recorded for the first time from the Canary Islands in the south coast of Gran Canaria, on 2008 (OTERO-FERRER *et al.*, 2015). This species is distributed from Senegal to Angola (FROESE & PAULY, 2017), and probably its occurrence in the area responds to a process of natural expansion, but this hypothesis remain unclear.

Family Blenniidae

Microlipophrys velifer (Norman, 1935) (Figures 3)

Eight specimens were observed in the environment but we could only examined images of four of them. The sighting occurred in the rocky intertidal zone in Garachico (28° 22.44'N 16° 45.97'W Tenerife), 28 May 2017. None of them exhibited a colour pattern of an adult male. We also studied multiple photos from three different localities of Gran Canaria: Sardina del Norte (28° 09.195'N 15° 41.940'W), El Burrero (27° 54.67'N 15° 23.10'W) and Arinaga (27° 51.45'N 15° 23.14'W). In these localities, the populations are bigger than in Garachico, and territorial adult males in reproduction have been observed; in the three localities, the same habitat pattern coincides (vertical walls of rocky intertidal zones sheltered or exposed to the waves, with tightly fitting bore holes where they take shelter, sometimes staying completely out of the water).



Figure 2.- A: *Cantherines macrocerus* (Punta del Hidalgo, Tenerife): **B:** *Hippocampus algiricus* (Las Caletillas, Tenerife).



Figure 3.- *Microlipophrys velifer*. A: Female or juvenile; B: Male (Tenerife); C: Male with courtship livery (El Burrero, Gran Canaria).

This small fish was observed for the first time in Canary Islands on 2002, in Sardinia del Norte (BRITO *et al.*, 2002). In addition to the Canary Islands, it is distributed from Mauritania to Angola (WIRTZ & BATH, 1982 and 1988; BATH & WIRTZ, 1992), including São Tomé and Príncipe islands (WIRTZ *et al.*, 2007); according to WIRTZ *et al.* (2013) records from Cape Verde Islands are misidentifications with endemic *Microlipohrys caboverdensis* (Wirtz & Bath, 1989). *M. velifer* is well distinguished by its colour pattern, particularly by a large, dark eye-sized spot on side of head posterior to eye, and also by the colour pattern of the territorial adult males during the breeding season (WIRTZ & BATH, 1982 and 1988). The occurrence of this species in the Canary Islands seems to be a natural process of range extension, probably related to the increasing of water temperature.

4. DISCUSSION

The littoral ichthyofauna of the Canary Islands has experienced a tropicalization process since the late 80s and the early 90s, that seems directly related to the increasing of sea water temperature (BRITO *et al.*, 2005; FALCÓN, 2015; FALCÓN *et al.*, 2015). The sea surface temperatures of Canary Islands have increased due to the climate change, with an average value of 0.28 °C per decade for the period covering from 1982 to 2013, more markedly during the wintertime, resulting in a current sea surface temperature range of 17-25 °C and an average value of 21 °C (VÉLEZ *et al.*, 2015). Unquestionably, this scenario has been favoured the occurrence, settlement and expansion of species with warm water affinities.

The tropicalization process has been detected in subtropical and temperate regions, as commented above, although its intensity is higher in border zones between tropical and subtropical biogeographic areas, such as the Canary Islands (BRITO *et al.*, 2005; FALCÓN, 2015). In many cases, thermophilic species recorded in the Canaries seem to respond to a natural process of geographic spreading to higher latitudes, across the biogeographic border located at Cabo Blanco (African coast), where a thermic discontinuity causes a change between warm-temperate and tropical faunas (SPALDING *et al.*, 2007; BRIGGS & BOWEN, 2013; ALMADA *et al.*, 2013). On the other hand, new tropical fish species found close to or in the surroundings of main harbours are suspected of arriving as consequence of maritime traffic as introduction vector (ballast water transport and associated fish to oil platforms) (BRITO & FALCÓN, 1996; BRITO *et al.*, 2005; BRITO *et al.*, 2011; FALCÓN, 2015; FALCÓN *et al.*, 2015; TRIAY-PORTELLA *et al.*, 2015; PAJUELO *et al.*, 2016). In the case of the oil platforms, a very important vector of species introduction in the Canary Islands since 2011, their slow navigation makes it possible for fishes associated to platforms hulls (small and large specimens) to travel long distances, very far from their original areas of distribution (FALCÓN, 2015; FALCÓN *et al.*, 2015; TRIAY-PORTELLA *et al.*, 2015; PAJUELO *et al.*, 2016). FALCÓN *et al.* (2015) reported 8 tropical fish species introduced by this vector, and at least two of them have viable reproductive populations in Gran Canaria *Hypleurochilus pseudoaquipinis* and *Abudefduf hoefleri* (FALCÓN, 2015; FALCÓN *et al.*, 2015; ESPINO *et al.*, 2015b).

The areas where the specimens were found in the present study, their original geographic distributions, and their biological and ecological characteristics (high mobility in juvenile or adult stage, rafting-like behaviour, and larval dispersal) allow us to think in nat-

ural expansion processes by their own means. This hypothesis is more likely in the cases of *Uraspis secunda*, *Psettodes* cf. *bennettii*, *C. capensis* and *Cantherhines macrocerus*. There are several similar example previously recorded, and of some of them expanded rapidly and have stable populations throughout the archipelago. The last one was *Parablennius goreensis* (Valenciennes, 1836), a blenny distributed relatively close to the Canaries (Banc d'Arguin, Mauritania (BATH & WIRTZ, 1992)) and with a high dispersion capability; it was recorded for the first time in Tenerife on 2012, and currently it has large populations throughout the Canary Islands (FALCÓN *et al.*, 2015). Concerning to *Paraconger macrops*, previously only known from Azores and Madeira, it is probably a native species which remained unnoticed due to its habitat and nocturnal behaviour, if it is definitely confirmed that the individual sighted belongs to this species.

It seems evident that increasing of sea water temperature range and average (Velez *et al.*, 2015) in the canarian waters is contributing to the colonization by species of tropical origin, and can explain the expansion of native species with warm water affinities from the westernmost islands to the easternmost ones, following the Canary thermal gradient (BRITO *et al.*, 2005; ESPINO *et al.*, 2014; FALCÓN, 2015). This phenomenon can also explain the re-emergence of marginal populations of species located in their northern limit, such as the case of at least two species occurring in the Canary Islands, the moray *Gymnothorax vicinus* (Castelnau, 1855) (BRITO *et al.*, 2014), and the snapper *Lutjanus dentatus* (Duméril, 1861) (GARCÍA-MEDEROS & TUSET, 2014; A. Brito, unpublished data). Furthermore, non-native tropical species established some time ago could expand more easily. *Hippocampus algiricus* and *Microlipophrys velifer* registered in this study seem to respond to a relatively recent expansion along the archipelago, once their populations were consolidated in Gran Canaria. *H. algiricus* was recorded for the first time on 2008 (OTERO-FERRER *et al.*, 2015) and *M. velifer* on 2002 (BRITO *et al.*, 2002), both of them in only one locality.

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